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the water with its tail to propel itself forward, it performs a double task; one part consists in pushing backwards a certain mass of water with a certain swiftness, and the other in pushing on the body in spite of the resistance of the surrounding fluid. This last portion of the task only is utilized. It would be greater if the tail of the fish encountered a solid object. Almost all the propelling agencies employed in navigation undergo this loss of labor (*travail*) which depends on the mobility of the *point d'appui*. The bird is placed among conditions especially unfavorable.

Professor Marey ends his first lecture with a discussion of the division of the muscular force between the resistance of the air and the mass of the body of the bird. His second and third lectures are on the resistance of the air, illustrated by mathematical and physical data, and the exhibition of his peculiar and delicate machinery for solving these problems by actual experiment.

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## REVIEWS.

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THE GEOLOGY AND PHYSICAL GEOGRAPHY OF BRAZIL.\*—In gleaning after some of the most notable of the world's travellers who have visited Brazil, little enough would seem to be left for another explorer in the same field. By steadily pursuing, however, for the most part one line of study, though a most comprehensive one, our author as a geologist has brought together in this readable book a simple, clear, philosophic account of Brazilian geology in its widest sense, which, while doing justice to the preceding writers, contains a vast deal of novel information and does decided credit to American geographical and geological science. Our really good, carefully prepared books of travel can be counted on the fingers' ends. This new candidate for favor may well be included among the select few. In Humboldt's famous "Travels" and "Views of Nature" we have the results of years of travel by a natural philosopher; in Bates's and Wallace's narra-

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\*Thayer Expedition. Scientific Results of a Journey in Brazil. By Louis Agassiz and his travelling Companions. Geology and Physical Geography of Brazil. By Professor C. F. Hartt. With illustrations and maps. Boston: Fields, Osgood & Co., 1870. 8vo, pp. 620. \$5.00.

tives we receive the impressions of single-minded zoologists as to the natural scenery, the customs of the people, the habits and strange ways of beasts, birds and insects; the works of Herndon, Gibbon, and Orton, are contributions to the geography of the Amazon valley; and in Fletcher and Kidder, and Burton, we see the human aspect of Brazilian life. To fill up these sketches, more or less fragmentary and random, we need a faithful study by a master with the details elaborated with scrupulous care.

To begin with, we need to know how the South American continent was built up, and the history of the changes by which it became so rich and fertile, as well as the physical and climatic peculiarities which have determined the genius of its inhabitants, and will hereafter influence their progress in civilization. The materials for such a work have been most industriously gathered by Professor Agassiz and his assistants, and the present volume, which we owe primarily to the liberal spirit of Mr. Thayer, and to Professor Hartt's ardor in making a second, independent visit, assisted by generous friends in New York, is the first fruits of these new explorations.

The volume before us does not touch specially upon the physical geology of the Brazilian Andes and head waters of the Amazon. The author confines his studies mainly to the geology and geography of the coast provinces from Rio de Janeiro to Pernambuco. Meanwhile, he gives the results of others who have written on the geology of the whole empire, so that the work gradually and naturally enough expanded into a general view of the subject. As a necessary part of the author's especial researches, the marine fauna of the shores between Rio and Pernambuco was quite fully investigated, and the animals collected were placed in the hands of experts for identification. Coral reefs of considerable extent were discovered midway between the cities of Rio and Bahia, the few reef-building species of corals being closely allied to those of the West Indies, while the crabs, star-fishes and sea-urchins scattered over the reefs were largely West Indian species, showing that the whole assemblage of these animals was a southerly extension of the West Indian fauna. Indeed, there is scarcely a break in the continuity of life as we go from the peninsula of Florida to Cape Frio. The differences between the two extremes are often great, but the passage from the one to the other is graduated. The two American continents grew up like

twin brothers under the same laws, and with the same treatment at nature's hands, and stand to-day not rivals, but complements of each other. We do not find those strong contrasts in their physical and biological features, that we do in the opposing lands of Asia and Australia, where two continents almost join hands, and yet are most strangely opposed.

For instance, Professor Hartt, seconded by the decision of Dr. Sterry Hunt, finds that the fundamental gneiss rocks of Brazil are the exact repetition of the Laurentian rocks of Labrador, Canada and the Adirondacks. The gold bearing rocks of the province of Minas, of probable Lower Silurian age repeat (oddly enough even to their geographical names) the characters of the auriferous strata lying about the basin of Minas in Nova Scotia. "The coal basins lie just south of the tropics, but within the range of the palm, and they are a coast formation, corresponding in this respect to the coal basins of Acadia, Massachusetts and Rhode Island." To continue the wonderful parallelism, at a later chapter in the geological history of Brazil, the Triassic Period, were deposited rocks agreeing precisely in physical characters with the New Red sandstones of the Connecticut valley. The Cretaceous rocks embrace species of Ammonites considered by Prof. A. Hyatt as identical with Texan forms, which flourished on both sides of the Andes-Rocky Mountain chain, and lived in a sea which covered Brazil, Peru, and Texas alike, before the appearance of the Isthmus of Panama. The reptilian remains examined by Professor O. C. Marsh indicate crocodiles and gavials and others of the same genera as those found in the marls of New Jersey. The Tertiary clays and sands are less like those of other lands, so far as regards their fossils, the types being more specialized, ushering in the present tropical life of Brazil.

The close analogy to the geological history of our northern continent, is, in the author's view, farther carried out by Agassiz's supposition of a continental Brazilian glacier. Here geologists differ, and most of them dissent from such a startling view. Professors Agassiz and Hartt do not know otherwise how to account for the presence of their "unstratified" "drift" clays and sands, often gold bearing, which are spread over the whole coast area from Rio to Pernambuco, and "in the valley of the Amazonas westward to the confines of Peru." Geologists will more generally credit the truth of the theory of the glacial origin of this thin

sheet of clay and sand, when the rocks beneath are found to be grooved and polished, when the coast clays are found to contain glacial, arctic shells, and the transported boulders described by the authors are more numerous and unmistakably of ice origin. But the grand objection to the theory of the former existence of a continental glacier in tropical America, is the unbroken continuity of tropical life since the close of the Tertiary period. While the coral reefs of Florida were slowly rising above the waves of a heated, equatorial sea, the waters of New York bay, and Massachusetts bay were the home of the walrus, the great auk, and the arctic seals, and the ocean depths were peopled with a truly arctic assemblage of animals and plants. At Charleston, however, the seas, as indicated by the fossils of the post-tertiary period, were not much colder than now, and the Floridian fauna was as tropical as now. Meanwhile in Brazil flourished giant sloths, and other quadrupeds, which roamed over the Pampas, while their ally, the Hairy Mammoth, braved the snows of the northern woods and prairies. It would be difficult for us to imagine that the valley of the Amazon differed so greatly in its climate at that time, and not leave behind the usual marks (at least more than Agassiz and Hartt here indicate) of an ice period. The deposit of Tertiary shells at Pebas, about two thousand miles from the mouth of the Amazon, described by Conrad, and discovered by Professor Orton in Professor Agassiz's Amazonian "drift," must effectually settle the question of the Amazonian beds at least. There may have been local glaciers on the Organ mountains about Rio.

An interesting sketch of the Botocudos, a very degraded Indian tribe, without a belief in a supreme God, is appended to Mr. Hartt's narrative, of which we would not take leave without referring to its value to the colonist and capitalist, from its full accounts of gold and diamond mines, and other natural productions. The Brazilians will remain under lasting obligation to the author, who has given them a most compact and accurate account of the geology and mineral wealth of their magnificent country. Since its publication, Professor Hartt has led a new expedition to Brazil, accompanied by a large corps of assistants, to make fresh explorations about the mouth of the Amazon. The Emperor of Brazil, who has already done so much towards developing the natural resources of his empire, might do much for its advancement by instituting a geological survey under the direction of one so familiar with the subject as our author.